WHITE PAPER

Knowing What We Know: Supporting Knowledge Creation and Sharing in Social Networks

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Abstract

Many early knowledge management initiatives focused heavily on information technology and codified knowledge and so missed performance improvement opportunities from interventions targeting knowledge embedded within networks of employees. Despite advanced technical solutions employed to manage organizational knowledge, we continue to find that people are often more reliant on other people than they are on databases when seeking answers to unstructured questions. As a result, organizations creating more cohesive networks on knowledge related dimensions are better able to collectively solve problems, create new knowledge and transfer explicit and tacit knowledge embodied within employees. The following article reports on a cross-industry research program assessing ways to promote knowledge creation and transfer in networks of employees. Specifically, we have found four characteristics of relationships important for knowledge creation in networks: 1) knowing what others know; 2) having access to other people's thinking; 3) having people be willing to actively engage in problem solving; and 4) having a safe relationship to promote learning and creativity. Mapping these dimensions in social networks yields targeted social and technical interventions managers can employ to improve a network's ability to create and share knowledge.

Crafting an Answer

> "So the call came in late on Thursday afternoon and right away I wished I hadn't answered the phone. We had received a last-second opportunity to bid on a sizable piece of work that the Partner on the other end of the line really wanted to pursue. Unfortunately I had little experience in [the subject matter] but happened to be the one with availability at the time. I had no clue how to even begin looking for relevant methodologies or case examples, so my first move was to tap into my network to find some relevant info and leads to other people or databases. And in fact I relied pretty heavily on this group of people over the next couple of days. For example, Seth was great for pointing me to other people and relevant information, Paul provided ideas on the technical content of the project while Jeff really helped in showing me how to frame the client's issues in ways that we could sell. He also helped navigate and get buy-in from the client given his knowledge of their operations and politics…I mean the whole game is just being the person that can get the client what they need with [the firm's] resources behind you. This almost always seems to mean knowing who knows what and figuring out a way to bring them to bear on your client's issue." --- Anonymous Interviewee.

The way in which this manager relied on his network to obtain information and knowledge critical to the success of an important project is common and likely resonates with your own experience. Usually when we think of where people turn for information or knowledge we think of databases, the Web, intranets and portals or other, more traditional, repositories such as file cabinets or policy and procedure manuals. However, a significant component of a person's information environment consists of the relationships they can tap for various informational needs. For example, Allen (1984) found that engineers and scientists were roughly five times more likely to turn to a person for information than to an inanimate source such as a database or a file cabinet.[1] In other settings, research has consistently shown that who you know has a significant impact on what you come to know, as relationships are critical for obtaining information (e.g., Simmel, 1950; Granovetter, 1973; Allen, 1984; Burt, 1992; Rogers, 1995; Szulanski, 1996; Shah, 1998) and learning

[1] This finding has been recently replicated despite the explosion of distributed technologies. Cross (2000) conducted in-depth interviews with forty managers in a consulting firm and found that, despite leading-edge knowledge management technologies and practices, 85% of the respondents reported obtaining information critical to the success of an important project through their network of contacts.

how to do your work (e.g., Lave & Wenger, 1991; Brown & Duguid, 1991 & 2000; Orr, 1996; Wenger, 1998).

Particularly in knowledge intensive work, creating an informational environment that helps employees solve increasingly complex and often ambiguous problems holds significant performance implications. Frequently such efforts entail knowledge management initiatives focusing on the capture and sharing of codified experiences and re-usable work products (Stewart, 1997; Davenport & Prusak, 1998; Davenport, De Long & Beers, 1998; O'Dell & Grayson, 1998; Ruggles, 1998). To be sure these so-called knowledge bases hold pragmatic benefits because they bridge boundaries of time and space, allow for potential reuse of tools or work products employed successfully in other areas of an organization and provide a means of reducing organizational "forgetting" as a function of employee turnover. However, such initiatives often undervalue a crucial "form" of knowledge in organizational settings: the employees and their network of relationships that provide an ability to dynamically solve problems and create new knowledge (Kogut & Zander, 1992; Nonaka & Takeuchi, 1995; Prusak & Fahey, 1998; Nonaka & Konno, 1998).

As we move further into an economy where collaboration and innovation are increasingly central to organizational effectiveness, we must balance our focus on the technical and social aspects of knowledge management. Certainly we can expect emerging collaborative technologies to facilitate virtual work and skill profiling systems to help with the location of relevant expertise. However, as was so poignantly demonstrated by reengineering, technology alone can only accomplish so much in the pursuit of improving business performance (Hammer & Champy, 1993; Hammer & Stanton, 1995). Improving efficiency and effectiveness in knowledge-intensive work demands more than sophisticated technologies — it requires attending to the often

idiosyncratic ways that people seek out knowledge and solve problems in organizations. Emerging collaborative technologies will be of limited use if not placed upon a foundation of social relationships effective at knowledge creation and transfer.

With this in mind, we initiated a research program to determine social and technical means of improving a human network's potential to create and share knowledge. The first step in our research was to understand the characteristics of relationships that yield effective knowledge creation and sharing in human networks. The second step was to map these dimensions of relationships among critical networks of people in various organizations. Working with a consortium of Fortune 500 companies and government organizations formed to study social aspects of knowledge management, we developed empirical support for relational characteristics that facilitate knowledge creation and transfer as well as insight into effective social and technical interventions to improve knowledge creation and sharing in networks.

Relational Dimensions Facilitating Knowledge Creation and Transfer

Put an organizational chart (the formal structure) in front of almost any employee, from line-worker to executive, and they will tell you that the boxes and lines do not reflect the way that work gets done in their organization. These people intuitively know that coordination and work often occur as a product of informal relations rather than through traditional hierarchical channels or established policies and procedures. The significance of these networks of relationships (or the informal structure) seems to only be increasing today with trends toward 'boundaryless' organizations and telecommuting (Hirschhorn & Gilmore, 1992; Kerr & Ulrich, 1995). Thus as we seek to promote an organization's ability to share and create knowledge we certainly can look to formal organizational design features; however, we must also attend to the ways in which people

in networks become able to leverage each others' knowledge. Social Network Analysis (SNA)—a tool for mapping and analyzing relationships among people (or departments) within an organization—offers a structural means to understand how knowledge creation and sharing occurs within networks (Scott, 1990; Wasserman & Faust, 1994).

As a tool, SNA provides a means to represent networks where effective collaboration can yield strategic advantage. However, we found limitations in the way in which social network researchers have assessed "advice" or "information" networks to date (see Monge & Contractor, 2000 for a review). First, aside from the concept of tie strength, the network literature provides little insight into the characteristics of relationships that promote **effective** knowledge transfer. While we have evidence that ineffective relationships can impede knowledge transfer (Szulanski, 1996), we have little understanding of the characteristics of relationships that make a network effective at sharing and creating knowledge. Thus a first point of departure in our research was to determine what makes a relationship effective in the creation of knowledge, because by understanding this we could suggest interventions for networks.

Second, the traditional means of mapping an information or advice network has been based on who helped whom with current or past tasks rather than who might be helpful in tomorrow's opportunities. However, the group of people that one knows and has the *potential* to draw on for knowledge is not the same group of people uncovered by network questions identifying who *actually* obtained information from whom in the recent past. For example, it is often the case that people know of and are able to tap into a much broader network of relationships for information or knowledge than whom they have interacted with in the recent past for a given task. Thus, our second point of departure was to better understand social and technical means of improving a network's capacity to collectively recognize and act on new opportunities.

With these goals, we asked forty managers to reflect on a project completed within the past six months and identify all of the people who provided them with knowledge critical to the successful completion of that recent project. We then asked them to select the three most important relationships in terms of knowledge creation and sharing and had them carefully describe both the relationships and the way they were useful in helping to solve problems.[2] [3] Four features emerged that distinguished effective from ineffective relationships: 1) valuing what they know[4]; 2) having access to them; 3) having them actively engage in problem solving; and 4) having a sufficiently safe relationship to ask important questions.[5] Each dimension is described below.

Knowledge. The managers we interviewed often reported turning to contacts for information because they considered those people knowledgeable in relation to some aspect of the problem facing the manager. Thus, these contacts provided a critical extension to the manager's own knowledge when the manager had at least a semi-accurate understanding of what her/his contacts knew. Relationships were valued for

[2] Interviews generally lasted between two and three hours and followed a two-step process common in ego network studies (Scott, 1990; Wasserman & Faust, 1994). First, the composition of each respondent's advice network was determined using a name generator technique (Burt, 1984; Marsden, 1990). Then the characteristics of each relationship were further explored using name interpreter questions. In terms of theory development, we employed a case-based logic in data collection by doing semi-structured interviews guided by a pre-existing theoretical model (Yin, 1994) that we held 'loosely' to allow for inductive theory development (Glaser & Strauss, 1967; Lincoln & Gubba, 1985). Our initial framework was informed by streams of research in social exchange theory and social capital, social network analysis, transactive memory and distributed cognition, cognitive and social theories of learning and communication studies. Interviews were transcribed, coded and assessed for inter-rater reliability using typical content analysis procedures (Diesing, 1971; Lincoln & Gubba, 1985; Strauss, 1987; Miles and Huberman, 1994). A third party independently coded interview transcripts with 93% agreement. To further empirically establish the importance of dimensions uncovered in the qualitative work we conducted a follow on quantitative assessment. The relational dimensions uncovered in our qualitative work accounted for 41% of the variance in a model of knowledge seeking even after controlling for time in organization and formal hierarchical position.

[3] So the sample was composed of 120 relationships.

[4] This of course is subject to bias (Fiske & Taylor, 1984). However, one's perception of another's knowledge and skills, even if inaccurate, informs who is turned to for what.

[5] Readers interested in social capital may question why trust was not an explicit dimension. In the interviews, trust in another's intentions was NOT a defining characteristic of these relationships in terms of their effectiveness for acquiring information, knowledge or advice. However, trust did come into play in two different senses. First, under the definition of trust as predictability, we did find that being able to predict someone's relevant knowledge in relation to the problem at hand was important. Second, under the definition of trust as benevolence, the construct of safety was also important in the learning potential of a relationship.

knowledge in two qualitatively different ways. First, some people were often sought out for the specific knowledge they could contribute to some problem. Such people were often skilled in technical domains and were sought out simply for the information that they were likely to be able to provide. Second, other people were often not sought out for specific knowledge in relation to a problem but rather for their ability to help think through a tough issue. These people were tapped for advice in either defining or refining complex problems and were considered good at identifying and making salient important dimensions of such problems. For example, one manager indicated:

> "At [Company X] we had access to background information and you know lots of case studies and approaches that were really well written up. We had no experience in the practice though of actually applying it on an engagement. So what was specifically useful to me was to talk with Terry who helped me work some of this accessible content into a workable approach…What I needed to know was: How might we apply this given that we have not done it before. That was my key question. Rather than what do I need to know about this subject matter."

Access. Of course someone else's knowledge is only helpful if they are willing and able to make themselves accessible to you in a sufficiently timely fashion. Interestingly though, knowing how to gain access to someone else's thinking was not always straightforward, but a learned feature of the relationship that was critical to its effectiveness. Learning how to gain access to other people required one to develop an understanding of a person's response style and what medium was most effective for establishing contact. Many relationships that evolved into highly productive ones were initially very frustrating for the managers we interviewed as people often did not respond in the depth, fashion or timeframe that the manager had anticipated. However, once these managers learned a person's approach to responding, and so had more accurate expectations, they were better able to effectively tap into that person in ways that helped them solve problems. This simple shift of expectations often dictated whether people

were effective in realizing the benefit of other people's expertise or not. For example, one manager indicated:

> "I have gotten less frustrated the more I have worked with him because I have realized that it is hard to get him to stick to a schedule. So now when I meet with him I have a list of like ten things I need to get through. And we set up a meeting for 1:00 and I know that it is not going to happen until 2:30 or 3:00 or maybe not until the next day, but when I do see him I have my list and I am ready and we can run down it. It was important to learn to accept that rather than be frustrated by it..."

Engagement. Yet access alone does not always result in the kind of dialogue necessary to create actionable knowledge. More effective contacts tapped for knowledge tended to willingly and actively engage in problem solving rather than overwhelm someone with excessive information or offer solutions with little thought. It is important to note that engaging in problem solving often did not mean a four-hour problem solving session. Rather, it was a simple two step process whereby people would first ensure that they understood the other person's problem and then actively shape what they knew to the problem at hand. In short, they were effective teachers. Most importantly, this stands in stark contrast to other people our respondents indicated that often used their facileness to get out of trying to be helpful. For example, one manager indicated:

> "Some people will give you their opinion without trying to either understand what your objectives are or understand where you are coming from or be very closed in their answer to you. [She] is the sort of person who first makes sure she understands what the issue is. I have been around people who give you a quick spiel because they think they are smart and that by throwing some framework or angle up they can quickly wow you and get out of the hard work of solving a problem. [She], for all her other responsibilities and stature within the firm, is not like that."

We found this aspect of engagement particularly interesting because it highlighted an important dimension of knowledge transfer that is often overlooked. Often when we talk about knowledge transfer we focus on the acquirer of the knowledge. For example, Szulanski's (1996) study, while acknowledging the difficulty created by an arduous relationship, generally pointed to impediments to knowledge transfer from the

perspective of the acquirer of knowledge rather than the sender. This notion of engagement raises an alternative dimension—that our energies might be better spent attending to the sender of knowledge. Our interviewees indicated that a critical behavioral difference between effective and ineffective people lay with first understanding the problem and then shaping their knowledge to it. This is a behavior that if developed among a network of people could significantly improve knowledge creation and its effective diffusion.

Safety. Finally, asking for information can require the requestor to have some degree of trust in the other person (Lee, 1997). Such trust often shapes the extent to which individuals will be forthcoming about their lack of knowledge and concerns, as defensive behaviors can knowingly and unknowingly block learning in critical interactions (Argyris, 1982; Argyris & Schon, 1996; Edmondson, 1996). Virtually all managers interviewed indicated that they felt safe asking other people for help, often claiming that they were the kinds of people that were not afraid to admit their own ignorance. However, the managers did say that the relationships characterized as highly safe offered certain advantages in problem solving. First, they provided more learning value as respondents were not overly concerned about admitting a lack of knowledge or expertise. Second, several of the respondents also indicated that in the more safe relationships they could be more creative. An important feature of these relationships to them was that they were more willing to take risks with their ideas, with this often resulting in more creative solutions. One manager indicated:

> "[he] is always looking for the positive spin on something. I mean even if he thinks that is crap and if he really thought that, he would always always find something positive or he would say "Well I think we might be a little off track on that and heres why" and then say why and of course there is learning that comes from that."

Assessing a Network's Potential to Share and Create Knowledge

The managers we interviewed indicated that knowledge, access, engagement and safety were key characteristics of relationships that made them effective in knowledge transfer. In contrast, they also recounted numerous times when knowledge transfer **did not** happen due to one of the above dimensions not existing in the relationship (e.g., someone knew what they needed to know but did not make themselves accessible). With the importance of these four dimensions established, the second step of our research was to map each dimension within a critical network, such as research and development initiatives or new product development efforts, to get insight into ways to promote an entire network's potential to share and create knowledge. Mapping the social networks of groups that provide strategic advantage to an organization via their ability to share and create knowledge helps us understand and propose specific social and technical interventions to improve these networks.

This is an important advance over traditional network practices which, in terms of knowledge sharing, have largely focused on past patterns of communication or advice. If we have mapped a communication network and find that certain people are not as connected as they should be it is difficult to tell what to do. Simply proposing more or better communication is the oldest consulting recommendation in the book—and no one today really needs more meetings. By taking a look at the aspects of relationships underlying effective knowledge flow, we can offer more precise ways to improve a network's ability to create and share knowledge without overloading employees with yet more meetings or e-mail.

First, one can analyze the *knowledge*, *access*, *engagement* and *safety* networks separately to determine where a given group might be experiencing problems. For

example, if it is discovered that the *knowledge* network is sparse, it might make sense to consider a skill profiling system or action learning sets—technical and social interventions designed to help a network know what it knows. In contrast, if the *access* network is sparse, then it might make sense to consider peer feedback or technical means of connecting distributed workers (e.g., video conferencing, etc.) to make sure that people within the network have access to each other in a timely fashion. The important point is that each of the dimensions requires very different interventions to improve performance (we expand on these below). As a result, analyzing the networks individually provides more precise means of improving a network's ability to share and create knowledge than implementing a broad cultural intervention or distributed technology.

In addition, it is also instructive to assess the dimensions cumulatively to get a better understanding of a network's underlying knowledge creation and transfer potential. In doing this, we can analyze networks where pairs of relationships exist (e.g., both know and access) or networks where all of the relationships exist (e.g., know, access, engagement and safety). For example, we conducted a social network analysis of 38 members within a practice of a consulting organization. The first network question asked each person to indicate the extent to which they understood and valued the knowledge and skills of their colleagues. This question was answered on a 5 point scale ranging from strongly agree to strongly disagree for each of the other 37 people within the consulting practice. A network diagram of the results is in the top half of Exhibit 1.

|Editor's Note: Please Insert Exhibit 1 About Here|

The *know* picture demonstrates who in this network of people indicated that they know and value other people's knowledge and skills. Though relatively sparse compared

to similar networks we have assessed, this network does show a healthy core/periphery pattern without distinct subgroups (which might represent a variety of political or information flow problems). An interesting point to note in this diagram is the central people — B, C, D, M and T — as these are the individuals most likely to be tapped for informational purposes by the group.[6] Just as importantly, it is interesting to note the people around the edges of the network who are less connected (with one person being completely isolated). Ultimately, these people are relatively less utilized by the group and pose questions to management regarding why this might be.

The picture takes on added life when we also consider the *access* network where each person rated their colleagues on the extent to which they were accessible in a timeframe sufficient to help solve problems. Ultimately, both *knowledge* and *access* relations must be present for information sharing behavior in a group to be effective. It obviously does little good to value another person's knowledge if you are not able to access their thinking in a timely fashion. By combining the networks from these two questions, we get a view of relationships that contain both dimensions — ones where people both values what someone else knows and are able to access them. This network diagram is shown as the Know × Access picture in Exhibit 1.

Several things are interesting in this network. First, we notice a fairly marked decline in the number of connections among the group in comparison to the *knowledge* network. While many central people remained central, it is important to note that several people higher in the hierarchy shifted out to the periphery of the network. For example, we now see that D, J and G (the three partners in this group) are all out on the periphery of the network. Intuitively this makes sense (though it is often a surprise to those people

[6] This assertion was validated by interviews in this setting and quantitative models of knowledge seeking in several organizations.

in higher hierarchical positions). As people move higher within an organization their work begins to entail more administrative tasks which makes them both less accessible and less knowledgeable about the day to day more operational work of their subordinates. What network analysis affords in this picture is an opportunity to assess whether those in positions of formal authority are sufficiently central to the flow of knowledge, as well as to identify those people that truly are influential knowledge brokers in the group.

The third question asked of the 38 consultants was who in the group they could count on to actively engage in problem solving. The results of this question have been incorporated into the Know × Access × Engage picture in Exhibit 1. Again, when the *engage* network is added there is a significant decrease in the number of connections and this is not trivial in terms of a network's ability to solve problems. As outlined in the initial interviews, it is often those people who are willing to engage in problem solving that help both create actionable knowledge (rather than information overload) and ensure that we are solving the right problem. In this view, we clearly begin to see the importance of four people — B, C, M and P — for the network to leverage what it knows. Just as importantly, there has now been a marked increase in the number of people on the periphery of the network and five people completely disconnected.

Of particular interest at this juncture is the sub-group that has formed at the bottom right hand corner of the network. The mere existence of a sub-group is not necessarily a bad thing. On the one hand, a group that has splintered off from the main network can represent untapped knowledge and occasionally political problems that must be addressed. However, it might also be the case that to develop new products or services management will make room and time for people to innovate as General Motors did with their Saturn division or IBM with development of the PC at Boca Raton. A common practice among many organizations seeking creativity is to allow such a group

to form and be creative outside of the requirements of day to day work and the pressure that often exists to conform to current ways of doing things.

This was the case in this scenario. Roughly one year prior to this analysis, L had been asked to develop a new service line in a technical network application. To do so he hired several uniquely skilled people and spent a good bit of time pursuing development of the service offering and sales opportunities — activities that had little to do with the work of this particular group of consultants. As a result, this group had become isolated from the main group over time, which in and of itself was not necessarily a bad thing due to the group's unique charter. What was a problem was that this group had become linked back to the main network **entirely** through L. This put L in a particularly influential position and also made the consulting practice susceptible to his leaving — should he decide to go elsewhere this group would be largely detached from the workings of the practice. This is not to say that new relationships could not be formed over time, just that productivity would be greatly impacted as these relationships were renegotiated.

The final question we asked of this consulting practice determined whom each person felt safe discussing work related issues with. The results of this question when added to the three previous ones can be seen in the Know × Access × Engage × Safe picture in Exhibit 1. With the incorporation of the *safety* network there is very little change. This is because the *safety* network in this group was the most dense of all of the networks. Ultimately, this is a sound indicator of the culture of this group for knowledge creation and is obviously not a place we would look to intervene. It is also important to note that based on our experiences a dense safety network is not always typical in these scenarios.

Analyzing the combined network (i.e., Knowledge × Access × Safety × Engagement) provides a great deal of insight into who is critical as well as who is

currently less utilized within a group in terms of knowledge creation and sharing. Understanding who is central to a group indicates people that might **either** be bottlenecks **or** highly valued knowledge resources upon which the group is reliant. Only interviews providing an in-depth understanding of a network can tell, but these people do pose interesting questions to management. Has the group become too reliant on these people should they decide to leave? Are these people hoarding information and so are bottlenecks in terms of the group's knowledge creation and sharing activities? In contrast, should these people be rewarded for the somewhat invisible role they play in supporting a group from a knowledge perspective?

If we discover that people are central in these networks for legitimate reasons, management has an opportunity to begin acknowledging the work that these people do for the group. In the words of one of the people central in the network in Exhibit 1, "I spend about an hour and a half every day responding to calls and other informational requests…[and] …none of that time gets seen in my performance metrics." Network analysis makes such interactions that are critical to a group visible, thus providing an opportunity for management to acknowledge these people and the critical role they play. For example, management might choose to better support knowledge creation and sharing by offering central people such things as:

- Monies for efforts that might stimulate knowledge flow in a group via face-to-face meetings, or to purchase technologies such as groupware.
- Cognitive and social space to allow room for both individual and collective creativity and bonding to occur.

- Executive focus such as rewarding or promoting network enabling people to both acknowledge their efforts and signal the importance of this kind of work to others within the organization.

In addition to central or core individuals, we also find it important to better understand why some people are peripheral in these networks. It might be that people in these positions do not know what we thought they knew when hired. In these cases they are peripheral for a legitimate reason and so reflect development or re-staffing opportunities. Alternatively, it might be that these people are peripheral because they are relatively new and the organization's assimilation processes do little to help them integrate into a network of colleagues. Given the increased turnover many companies experience today, it is important to find ways to move people into the central part of the network more and more quickly. This is often a process that can be improved by focusing on the way that new people are brought into a group. At best, what most organizations do when hiring a new person is to hold orientation courses that teach the person about the computer system, their benefits and, perhaps, some homilies about the culture and history of the company. It is rare to find practices where people are taught or provided with opportunities to know what other people know in the organization. Perhaps even more fatally, it is almost unheard of to find practices that teach the group what individuals or other practices know. This is a critical shortcoming since, with work increasingly being project-based, people will be brought into the center of the network primarily as a result of what other people understand about their knowledge and skills.

On a more conceptual level, the combined network view offers unique purchase on the elusive concept of organizational learning. Researchers in the field of organizational learning have clearly captured the importance of declarative (know-what)

and procedural (know-how) knowledge in organizational learning (e.g., Cohen & Sproull, 1996; Moingeon & Edmondson, 1996; Walsh & Ungson, 1991; Walsh, 1995; Sanchez & Heene, 1997; Walsh & Huff, 1997). In marked contrast, there has been far less attention paid to organizational learning as a product of relational understanding of others or know-who. Huber (1991: p. 89) claimed that an organization has learned when "through its processing of information its range of potential behaviors has changed." Thus if we are interested in promoting an organization's ability to react to new opportunities, we need to account for the ways in which people in networks become able to leverage each others' knowledge. Changes in the knowledge, access, engagement and safety relationships underlying a network's future information processing behavior provides one means of both descriptive and prescriptive traction on organizational learning.

Given the extent to which people rely on their contacts for information, this is not a trivial question and at one level raises new ways of thinking about groups and their performance in organizational settings. For example, rather than viewing senior management as a cross-functional team, it may be more appropriate to consider it a rather closed network that responds to opportunities presented by the environment. In this view, more effective top management teams would be those that could configure more effectively and efficiently around opportunities. Similarly, social network analysis can help in understanding the impact that certain people may have on the trajectory of a group over time. Organizations have often been claimed to be path dependent or constrained by what they know. Such notions as absorptive capacity, core rigidities or architectural knowledge have been claimed to lead to this path dependence over time (Cohen & Levinthal, 1990; Henderson, 1992; Leonard-Barton, 1995; Arthur, 1996). While critically important, this work has often been done at a level of abstraction that makes interventions questionable. In contrast, the combined view of these networks

provides some idea as to precisely whose knowledge is primarily responsible for what a group is likely to learn over time.

Promoting Knowledge Creation and Transfer

In applying these ideas in various organizations we have found two steps particularly important. First, it is important to identify points of knowledge creation and sharing within an organization that hold strategic relevance. The network of relationships that one chooses to map is often a product of an organization's strategy and how it presents itself and its products to the market. Typical domains yielding benefit include senior management networks, communities of practice and collaborative iniatives such as new product development, R&D units or joint ventures and alliances.

It is particularly fruitful to map collaborative relationships that cross boundaries of some form. Such boundaries might be hierarchical, functional, geographical or even organizational as in joint venture or merger and acquisition scenarios. Understanding how knowledge flows (or more frequently does not flow) across these various boundaries within an organization can yield critical insight into where management should target efforts to promote collaboration that has a pay off strategically for the organization. For example, we mapped the relationships of one Fortune 500 organization's top 126 executives to assess collaborative activity across divisions. This was an organization that had grown by acquisition over the past several years with the primary intent that acquired companies would go to market together. Thus the extent to which this group of leaders was collaborating to integrate offerings held strategic significance for the organization.

We conducted a social network analysis of this executive network to assess collaboration within and across divisions. While various network diagrams were generated, the most insightful view came from a simple table demonstrating collaborative

activity amongst this network of executives. Exhibit 2 outlines a table of the percentage of relationships that existed within and between each specific division (out of 100% possible in each cell). Looking at the diagonal of the table we determined the percentage of collaborative relationships that existed within the various divisions. This yielded an opportunity to learn from practices within one division and apply them in others where the work of each division required similar levels of collaboration. Similarly, we were also able to determine which of the merged organizations (termed divisions in Exhibit 2) had integrated well with other divisions. For example, a quick review of Exhibit 2 shows that divisions 3 & 4 had a relatively high degree of collaboration; whereas divisions 1 & 7 had minimal contact.

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Though not a traditional network diagram, this view of collaborative activity provided a great deal of insight into the inner-workings of the organization. The company had acquired various organizations with the intent that they collaborate in bringing their offerings to market. However, the social network analysis showed that there was only limited collaborative activity in pockets of the organization. Various reasons existed for this. In some settings members of the executive team were not sure of what a given division did and so did not know how to even think about involving them in their projects. In others, cultural barriers restricted people from seeking information outside of their own division. And in some the complementarity of product offerings that was presumed when an acquisition was made did not exist.

This kind of cross-boundary view identifies points where collaborative activity is not occurring due to organizational boundaries and provides a more targeted view as to

where interventions might be employed. It is often **not** the case that you want high collaborative activity amongst **all** departments within an organization. People have a finite amount of time to put into developing and maintaining relationships. What network analysis allows us to accomplish is to begin taking a portfolio approach to considering what constellation of relationships are worth investing time, energy and in some cases collaborative technologies in developing and maintaining. For example, in the disguised scenario outlined above, it was **not** critical that Division 1 be tightly connected to all other divisions to help the organization meet strategic objectives. To provide strategic value to the organization, Division 1 really only needed to be well connected to Divisions 3, 5 and 6. Thus, rather than engage in a company-wide initiative to improve collaboration, more targeted and ultimately more successful interventions were employed to facilitate collaboration at specific junctures.

Once a critical collective has been targeted, we have found that applying network analysis based on the four dimensions of knowledge, access, engagement and safety can improve a network's knowledge creation and sharing potential. We further summarize some of these ideas below.

Knowledge Dimension: How do we know what we know*?* Other people can only be useful to us in solving problems if to some degree we know what they know. Even if we are wrong, our initial perception will determine whether and how we tap into people going forward. Problematically, most of our team interventions focus largely on shared vision and process skills that help to create a harmonious environment, but do little to educate team members of each others' unique capabilities. This often does not help people performing tasks to know how or when to tap into colleagues' unique knowledge and skills in future initiatives. This is a larger problem than one may think on first blush. Studies consistently show that when work groups form to engage in a task they

experience what is called the unshared knowledge problem (e.g., Stasser, 1992 & 1995). Rather than engaging in discussions that help them to learn the unique backgrounds of individual members, they tend to focus on some domain that people have in common. Of course this is a natural human process. By finding common areas of interest, acquaintances or past experience, we are able to start a conversation with people we do not know. However, the result is that we often never get to an understanding of other peoples' capabilities until extremely late in a given effort (if at all).

In more staid times, working relationships developed as a product of interaction over longer time periods. This is surely not so in today's business environment. As we are working in an environment where we are increasingly forming and disbanding teams on a project basis to accomplish work, we must pay more attention to the way that we develop knowledge of others both within these initiatives and outside of them. If a network is sparse on the knowledge dimension, then both social and technical interventions designed to improve "knowing what we know" are warranted. For example, on a technical front an organization might implement a skill profiling system or a corporate yellow pages. On a social front, organizations such as the World Bank have organized their employees into thematic groups that have Help Desks whom anyone connected with the organization can contact. The individuals manning the Help Desks are able to route people to others within the thematic group who have expertise on a particular subject. Other companies and government organizations have regular Knowledge Fairs where teams, communities or departments can set up a booth and distribute information about the expertise that they have. Although this has limited scope it has proven effective in increasing awareness of the projects and knowledge activities taking place within the different departments and communities of the organization.

Access Dimension: How do we improve access to our collective knowledge?

Access undergirds the success of a network, especially in today's environment where we have little time to wait for written answers. Critical issues on which we may turn to others for help or advice require turnaround of some sort within increasingly tight time frames. For example, in the interviews of the forty managers in the professional services firm, those relationships that people estimated were accessible in twenty-four hours were by and large considered valuable relationships and ones that the person interviewed felt was worth maintaining. This fell off sharply for those that were estimated to be accessible in forty-eight hours, and those estimated to be accessible in seventy-two hours were relationships that the manager no longer considered valuable and put no effort into maintaining.

As organizations have become dispersed with people increasingly working from diverse locations, improving access has largely centered on technical interventions such as e-mail, cell phones, pagers, etc. Alternative ways of increasing access have included focusing on the benefits of knowledge sharing within the company's code of ethics. At Buckman Laboratories all associates are empowered to speak with any associate at any level; this is supported by a communication technology that gives each employee access to all other employees. Access is also heavily conditioned by physical proximity and the layout of workspace. Interestingly, Chrysler has gone full circle (from dispersion back to co-location) and has brought all the people involved in new car development into one building so that they can all have face to face access.

Engagement Dimension: How do we improve engagement in problem solving?

One of the most profound findings from our study of the forty managers was the importance of a person engaging with another in problem solving. Ultimately, such interactions led to actionable knowledge rather than information overload. Engagement

is a two-stage process of first ensuring one understands another's problem and then actively shaping what one knows to generate a solution—or teaching. British Petroleum is one organization that has begun to systematically recognize the importance of teaching by implementing peer reviews as an effective way to tap into others knowledge. Before engaging in any significant task the individual or group invites peers to provide input. Because the focus is performance, those with the most relevant knowledge and recent experiences are tapped to participate. Through this peer review process not only is performance on the task at hand improved, but people become much more aware of the unique skills and abilities others can bring to projects. This creates a natural reason for becoming familiar with the expertise of others. It also develops the needed norms of reciprocity and trust that make sharing of expertise a natural process.

Technological interventions to improve opportunities for engagement have included synchronous technologies such as VP Buddy at IBM, Same Time at Lotus or white boarding applications that allow for dispersed engagement in a common problem. Other successful interventions include the use of videoconferencing for visual interaction between people in different locations. This has been particularly important at British Petroleum where experts have been able to assist technicians who are working on oil rigs thousands of miles away. Experts at BP's offices have been able to engage in face to face contact with the on-site technicians to analyze problems.

Safety Dimension: How do we ensure that learning and creativity occurs? In terms of both creativity and the ability to ask questions that expose one's lack of knowledge, it is important to ensure that relationships are safe (at least from an informational perspective). The first means of doing this is by increasing the visibility of those relationships that are not perceived as entirely safe. Network analysis provides a means of making these non-safe relationships highly visible and so discussible by the

group (under appropriate conditions). Using network analysis as a form of 360-degree feedback (whether you disclose the names of people feeling unsafe or not) provides a means of individually beginning to correct the problem.

Importantly, these interventions often take two markedly different forms. First, if you see a network diagram where various people indicate that a specific person is not an entirely safe relationship there are interventions that can be taken with that person. Often such interventions just require creating an awareness, but may go in more depth as necessary. Just as importantly though, it is important to look for the people who may be claiming that a lot of other people are unsafe. In this scenario, someone claiming that a variety of other relationships are unsafe in many cases may be reflecting their own confidence levels.

Creating a greater degree of safety within relationships which allows for an increase in learning and creativity is dependent upon allowing relationships to develop over time. Although communications technologies such as e-mail are helpful in maintaining relationships, when creating relationships it is more important to increase the opportunity for face to face interactions between people. The World Bank has instigated a program of brown bag lunches to encourage the development of relationships between people. Another organization has encouraged face to face contact by monthly meetings between different groups of researchers. These meetings consist of a discussion session in the morning and a working session in the laboratory in the afternoon. This allows for a free flow of ideas within the context of a real working environment. It also allows for ideas to be experimented with which obviously leads to an increased opportunity for innovation. Buckman Laboratories has used a more top down approach by creating a code of ethics aimed at encouraging an atmosphere of confidence and cooperation amongst all of its employees.

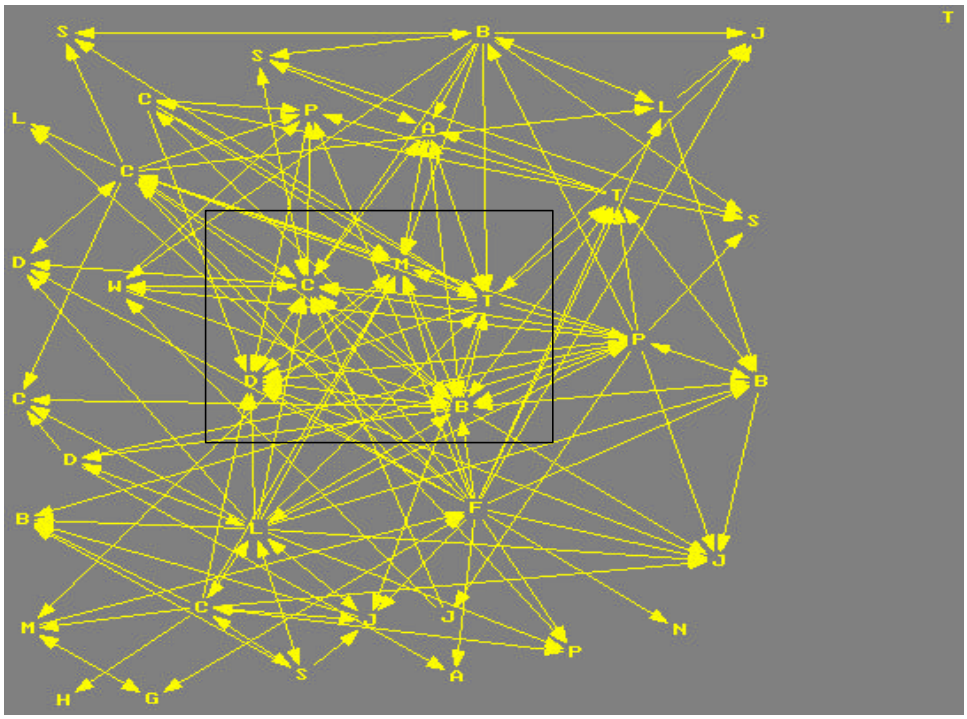
Conclusion

Where is the critical knowledge in the firm? Nelson and Winter (1982) proposed that it lay primarily in organizational routines. We propose that it also lies in the dynamic web of relationships existent in all organizations. A critical resource embedded within organizations is the knowledge that workers bring to work on a day to day basis. However, aside from human resource policies targeted to the attraction, development and retention of identified valuable workers, there has been little effort put into systematic ways of working with the knowledge that is embedded in people and their relationships (Sveiby, 1997). Given the extent to which people rely on their own knowledge and the knowledge of their contacts to solve problems this is a significant shortcoming. By introducing social network analysis to understand how a given network of people create and share knowledge, we are able to make these interactions visible and so actionable.

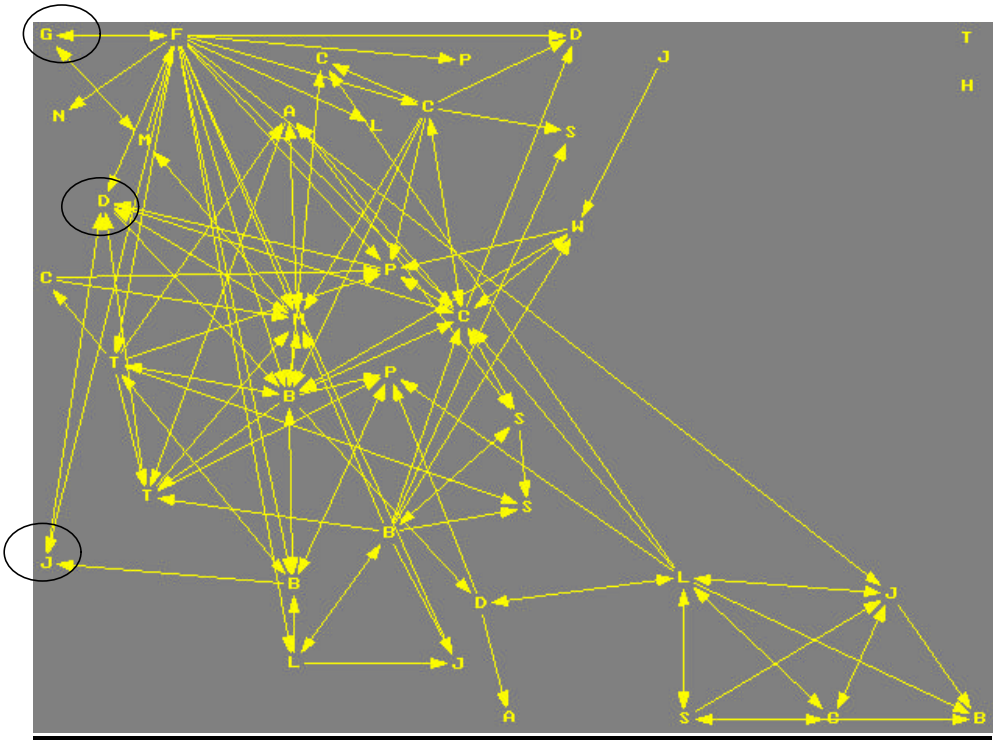
While social network analysis is not an entirely new concept, we have made its application more tractable by offering specific dimensions of importance to better understand how social networks create and share knowledge. A prominent sociologist recently indicated that the emerging issue of social capital was to be the "killer app" of network analysis. If this is the case, then rich and dense networks of relationships may not only work as knowledge enablers within organizations, but also hold promise for future assessment of the creation and value of social capital.

Exhibit 1

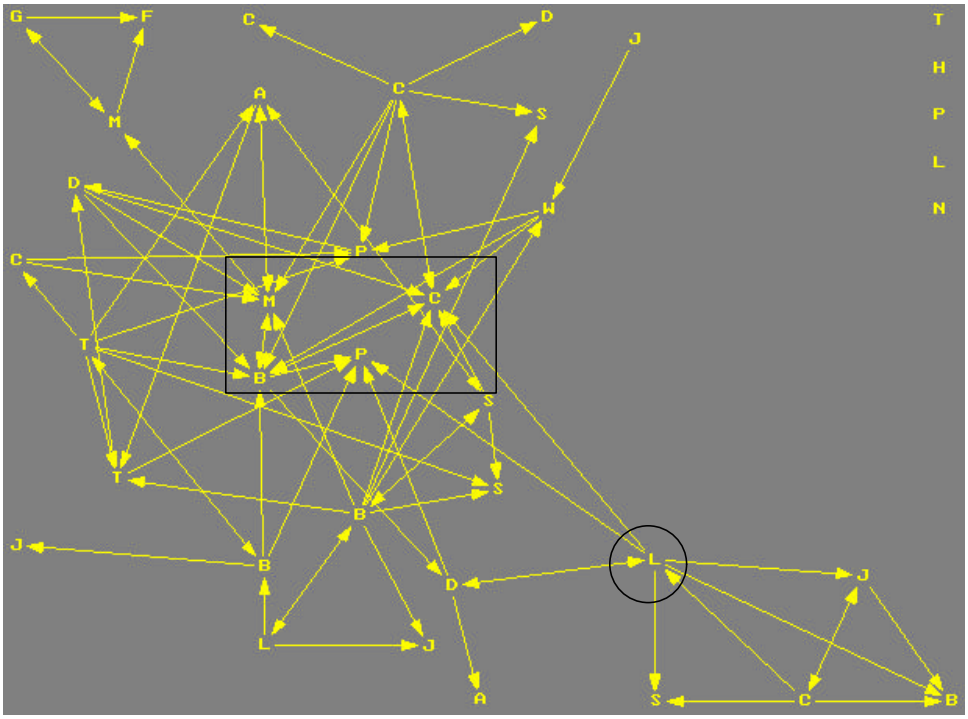
Know Network



Know × Access Network



Know × Access × Engage Network



Know × Access × Engage × Safety Network

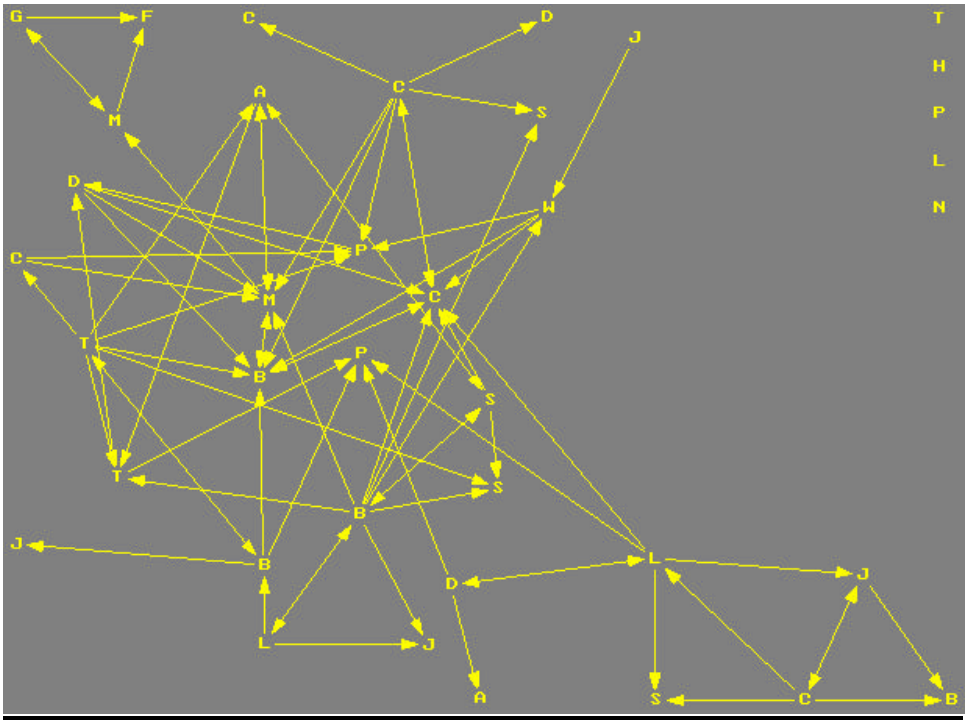


Exhibit 2

Cross-Division Collaboration

	Division 1	Division 2	Division 3	Division 4	Division 5	Division 6	Division 7	Division 8
Division 1	**33%**							
Division 2	5%	**76%**						
Division 3	11%	18%	**45%**					
Division 4	2%	11%	21%	**38%**				
Division 5	6%	7%	12%	6%	**75%**			
Division 6	7%	2%	13%	7%	2%	**76%**		
Division 7	1%	3%	16%	6%	8%	2%	**36%**	
Division 8	10%	2%	9%	6%	3%	10%	0%	**90%**
Avg.	6.0%	6.8%	14.3%	8.4%	6.3%	6.1%	5.1%	5.7%

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